Appendix E

The AN/TPQ-47 Radar

This appendix contains an overview of the system components and characteristics of the AN/TPQ-47 (Q-47) radar system. It provides technical employment considerations and tactics, techniques and procedures for employing the Q-47. This appendix also includes considerations and procedures for site selection, positioning, deployment, and safety.

SECTION I – TECHNICAL ASPECTS

AN/TPQ-47 EQUIPPED TARGET ACQUISITION ORGANIZATIONS

The Q-47 radar is organic to Heavy Division Target Acquisition Batteries (TAB), the TAB of Divisional MLRS battalions and Corps Target Acquisition Detachments (CTAD). Two Q-47 radars are organic to each of these organizations. In addition, the Q-47 is organic to the Target Acquisition Platoon (TAP), DS artillery battalion of the Interim Brigade Combat Team (IBCT) and the Radar Platoon of the HIMARS battalion of the Interim DIVARTY (IDIVARTY). The IBCT contains one Q-47 and the IDVARTY contains three Q-47. In addition, each corps has two Q-47s organized in a CTAD to support TBM and counterfire operations. This CTAD is assigned to both heavy and light corps and is provided in addition to the CTADs assigned to support light and airborne divisions within a corps.

HEAVY DIVISION TARGET ACQUISITION BATTERY

The Heavy Division Target Acquisition Battery is responsible for locating enemy indirect fire weapons, and registering and adjusting friendly artillery and in the division's battlespace. It locates indirect fire targets with its organic Q-36 and Q-47 radars. An assistant counterfire officer (WO/131A) and a target processing section are provided to the DIVARTY or FA brigade TOC to support counterfire operations. Q-36 radars are normally attached to DS FA battalions and controlled by the DS FA battalion S2. The target production section of the DIVARTY or FA brigade TOC normally controls Q-47 radars. The heavy division TAB survey section provides location and directional control to TAB elements and aids the DIVARTY or FA brigade survey section as required.

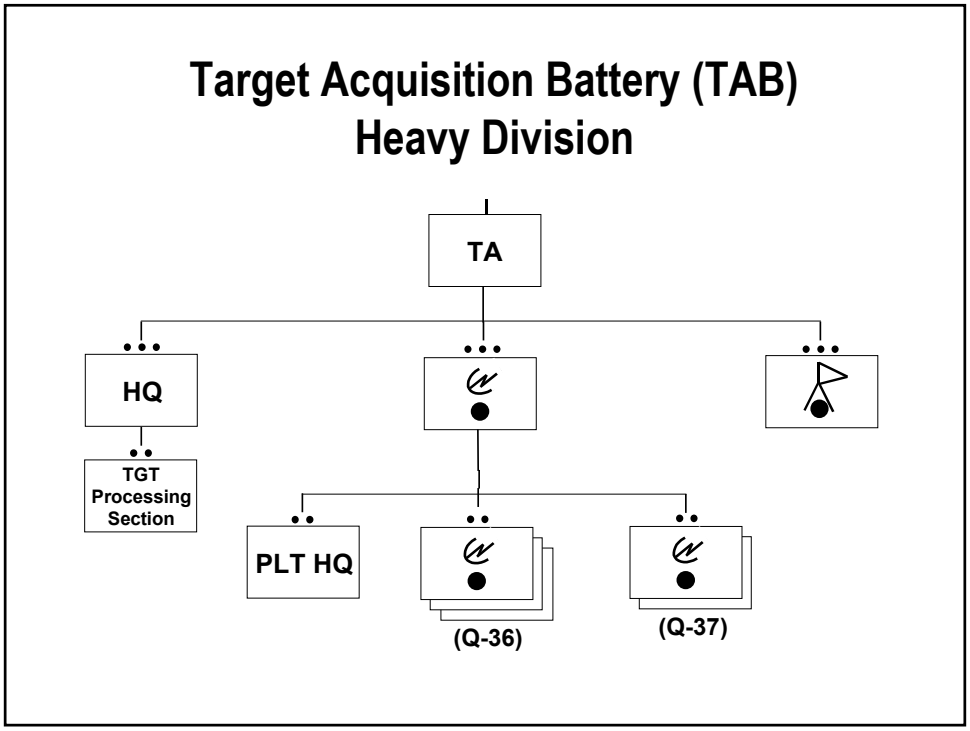

Figure E-1. Heavy Division Target Acquisition Battery

DIVISIONAL MLRS BATTALION TAB

The divisional MLRS battalion TAB is organic to the heavy divisional MLRS battalion. The divisional MLRS is organized with a HHS, Three six-launcher MLRS firing batteries and a TAB.

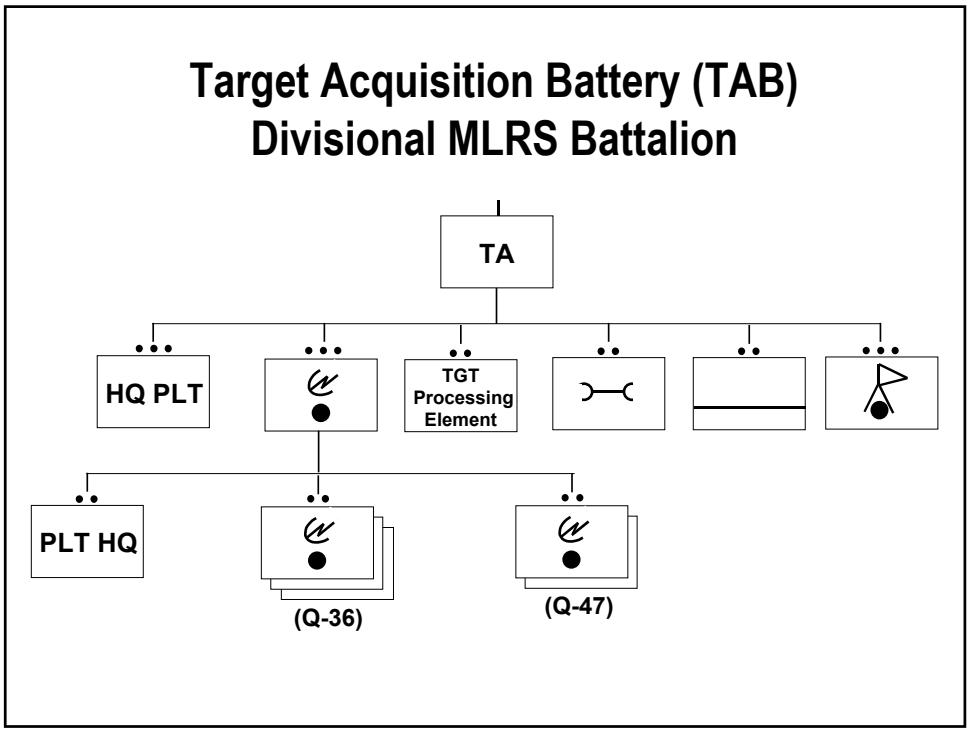

Figure E-2. Divisional MLRS Battalion Target Acquisition Battery

CORPS TARGET ACQUISITION DETACHMENT

The Corps Target Acquisition Detachment (CTAD) was originally assigned to corps on the basis of one per light division assigned to the corps. It was designed to support light infantry, airborne, and air assault division artilleries or field artillery brigades upon deployment. With the fielding of the Q-47, and additional CTAD will be assigned to each corps for retention and use by the corps. The mission of the Q-47 equipped CTAD is to provide acquisition of threat artillery, rocket, and missile systems to provide target intelligence and information to allow friendly forces to take force protection measures, enable counterfire mission processing and support TMD operations. The CTAD consists of a headquarters section, a PADS team, and two Q-47 radars. The processing (HQ) section is provided to corps artillery TOC, light, airborne, air assault division artillery TOC, or their designated counterfire headquarters to help process counterfire targets.

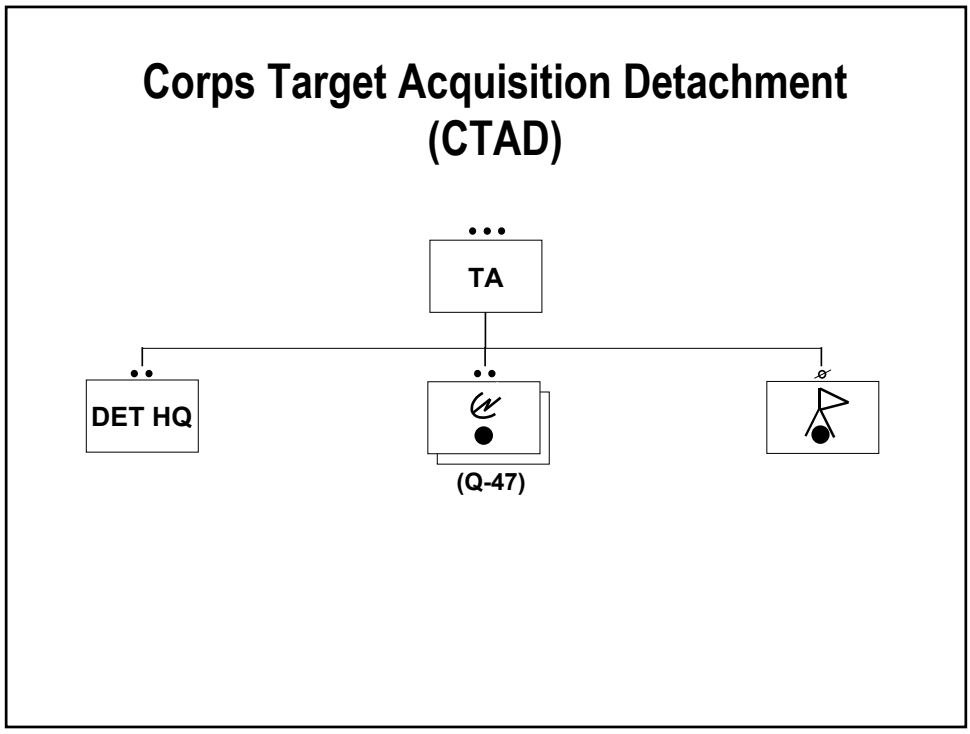

Figure E-3. Corps Target Acquisition Detachment

INTERIM BRIGADE COMBAT TEAM TARGET ACQUISITION PLATOON

The Interim Brigade Combat Team Target Acquisition Platoon (IBCT TAP) provides acquisition of threat mortar, artillery, and rocket systems to provide target intelligence and information to allow friendly forces to take force protection measures and enable counterfire mission processing. The platoon consists of one Q36 and one Q47 radar, a meteorological section and a survey section. The platoon deploys in whole or part within tailored force packages. Once in theater, the Fires and Effects Coordination Cell (FECC) controls the employment of the platoon and any additional counterfire radars attached or augmenting the brigade. When in theater, whether it deploys early or with the field artillery battalion, the platoon and/or individual radars will always establish direct digital and voice links with the FECC and may establish an AFATDS digital quick fire channel with a delivery unit. The meteorological section provides meteorological support to artillery, mortars and radars to enhance their accuracy. The survey section provides common survey to field artillery firing units and mortars when assets are available. The survey capability is limited and lacks redundancy because the section has only one position and azimuth determining system (PADS).

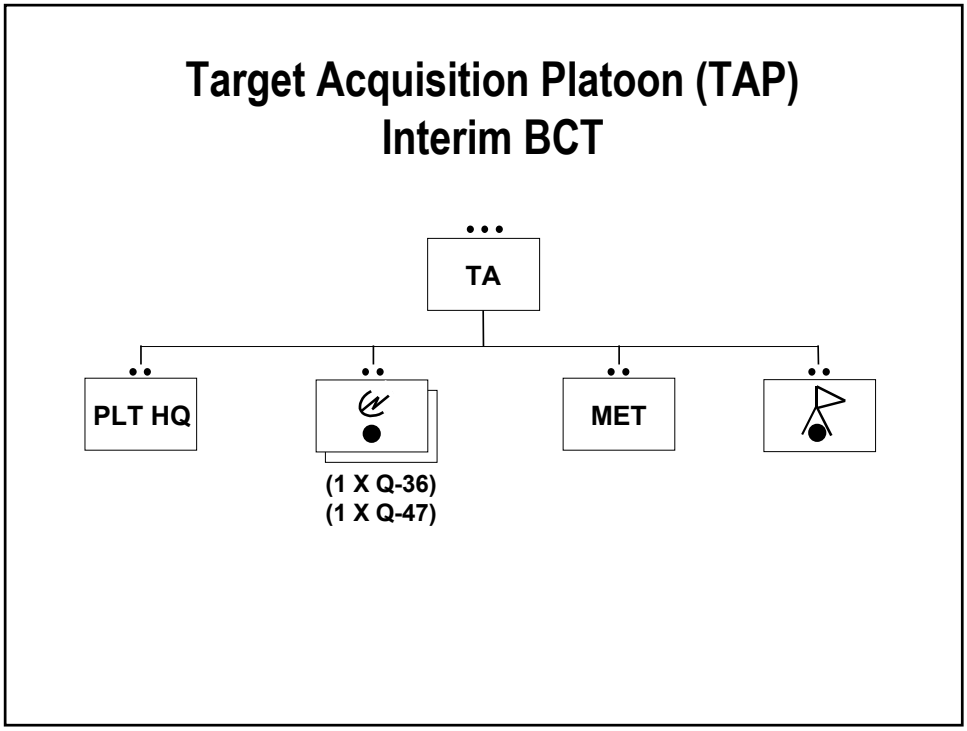

Figure E-4. Interim BCT Target Acquisition Platoon

INTERIM DIVARTY RADAR PLATOON

The Interim DIVARTY (IDIVARTY) Radar Platoon provides acquisition of threat artillery, rocket, and missile systems to provide target intelligence and information to allow friendly forces to take force protection measures, enable counterfire mission processing and support theater missile defense (TMD) operations. The platoon consists of three Q-47 radars, a meteorological section and a survey section. The platoon deploys in whole or part within tailored force packages. Once in theater, the Fires and Effects Coordination Cell (FECC) controls the employment of the platoon and any additional counterfire radars attached or augmenting the division. When in theater, whether it deploys early or with the HIMARS battalion, the platoon and/or individual radars will always establish a direct digital and voice link with the FECC and may establish an AFATDS digital quick fire channel with a delivery unit. During TMD operations, the radar may establish a direct link with the Army and Air Defense Missile Command (AAMDC) through the AFATDS in the AAMDC Attack Operations Cell. The meteorological section provides meteorological support to artillery, mortars and radars to enhance their accuracy. The survey section provides common survey to field artillery firing units and mortars when assets are available. The survey capability is severely limited and lacks redundancy because the section has only one position and azimuth determining system (PADS).

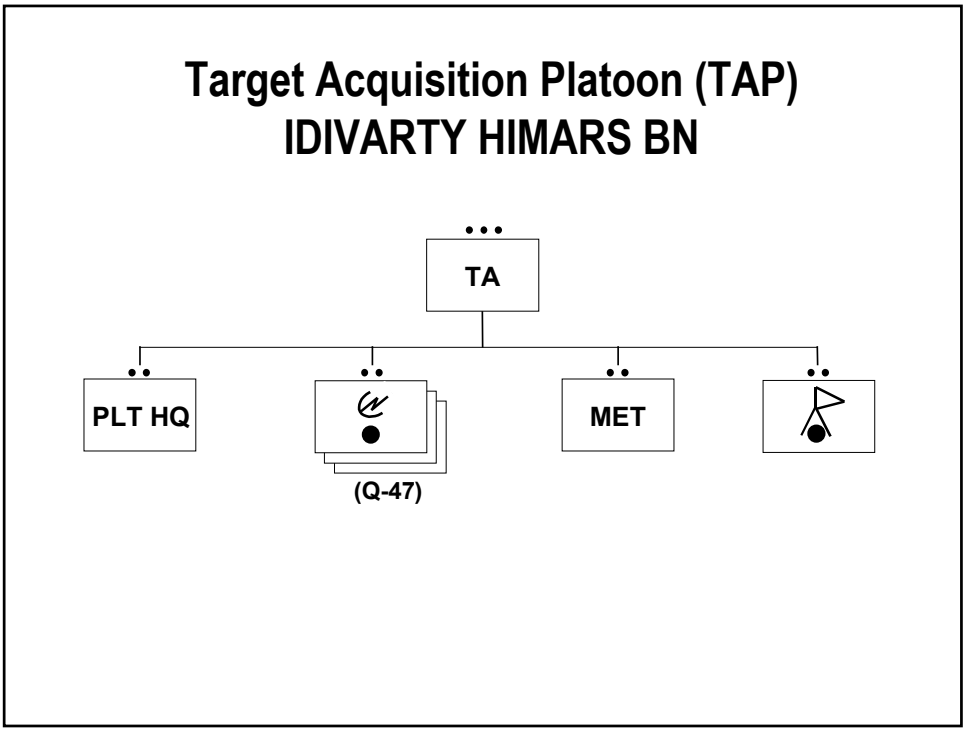

Figure E-5. IDIVARTY HIMARS Battalion Target Acquisition Platoon

AN/TPQ-47 RADAR SECTION

The Q-47 radar section is comprised of nine personnel. This is a decrease of three personnel when compared to the Q-37 section. The Q-47 section contains the same military occupational specialties as the Q-37. Table E-1 shows the section organization.

Table E-1. Radar Section Organization

Organization Title	Grade	MOS	Quantity
Target Acquisition Radar Technician	CW2	131A0	1
Section Chief	SSG	13R30	1
Senior FireFinder Radar Operator	SGT	13R20	1
FireFinder Radar Operator	PFC/SPC	13R10	4
Radar Repairer	SGT	35M20	1
Power Generation Equipment Repairer	SPC	52D10	1

SYSTEM CHARACTERISTICS

The Q-47 is the next generation replacement for the Q-37. The Q47 is a S-band phased array radar system that uses radar technology and computer-controlled signal processing to perform detection, verification, tracking, and classification of projectiles, rockets and missiles. The phased-array antenna allows the radar to switch beam positions electronically, thus providing a capability to search for new targets while simultaneously tracking targets already detected. It also enables the radar to detect and locate weapons firing

simultaneously from 25 to 50 different locations at ranges from 3-300 km while using three different modes of operation. The Q-47 is also capable of registering and adjusting friendly indirect fire while simultaneously maintaining hostile surveillance. The detection and location functions of the system are similar to the Q36(V)8 and Q37.

SYSTEM COMPONENTS

The complete Q-47 System consists of the following components:

- The Antenna Transceiver Group (ATG).
- The Operations Central (OC).
- The Portable Operations Suite (POS).
- The Prime Power Group (PPG).
- M1078 Truck Cargo.
- M1097A2 HMMWV Reconnaissance Vehicle.
- PU 806 trailer mounted generator.

The operational configuration consists of the ATG, OC, POS, and PPG as shown in Figure E-6.

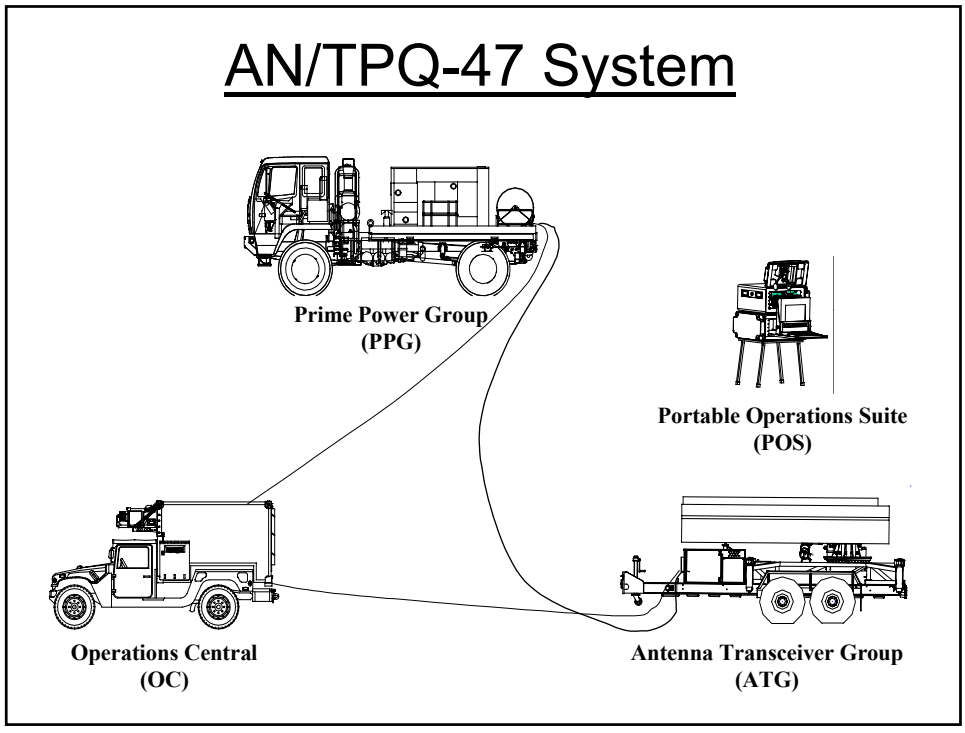

Figure E-6. The AN/TPQ-47 Operational System

ANTENNA TRANSCEIVER GROUP

The ATG is the main component of the radar. It consists of the antenna; electronics cabinet; trailer, pallet, and leveling system; and cabinet storage. The antenna contains the power amplification modules, power supplies and

MAPS/GPS. The electronics cabinet contains the power distribution unit, processor and associated software, and leveling controls.

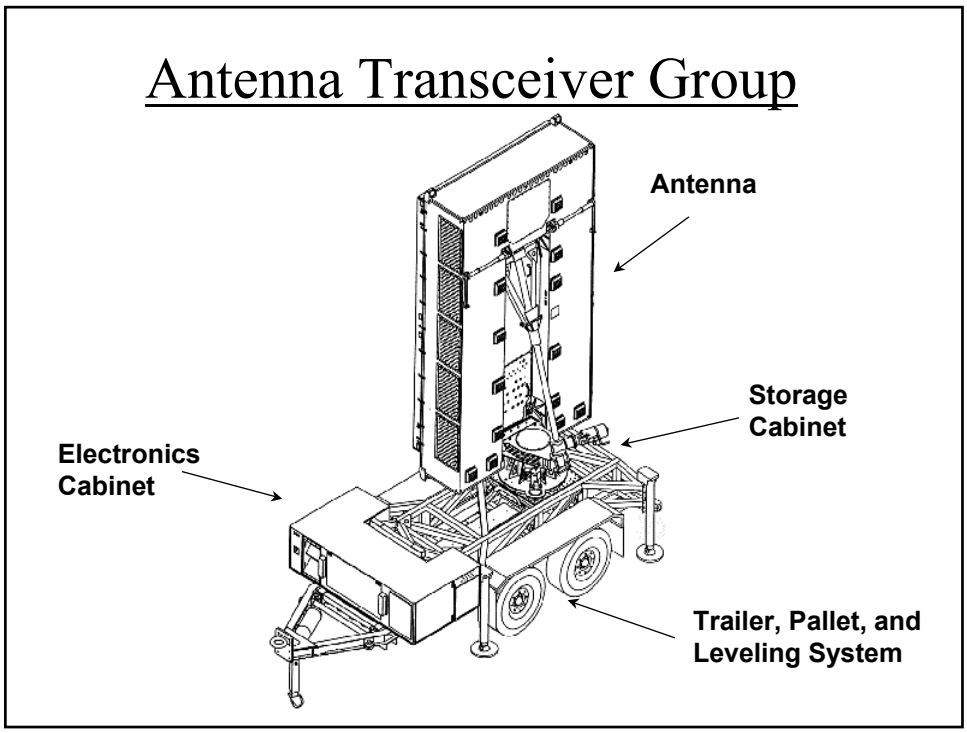

Figure E-7. The Antenna Transceiver Group

OPERATIONS CENTRAL

The operations central (OC) is the focal point for operating the Q-47. The OC consists of a modified AN/TPQ-36(V)8 shelter mounted on a HMMWV. The shelter contains two common hardware system-2 (CHS-2) computers (GD Versatile Computer Unit (VCU)), systems software, Force XXI Battle Command-Brigade and Below (FBCB2), and required communications equipment. During movement a VCU is removed from the OC and placed in the LMTV to support operations on the move. The available communications equipment includes an EPLRS, a tactical communications interface module (TCIM), an interface with the two ASIP radios contained in the ATG.

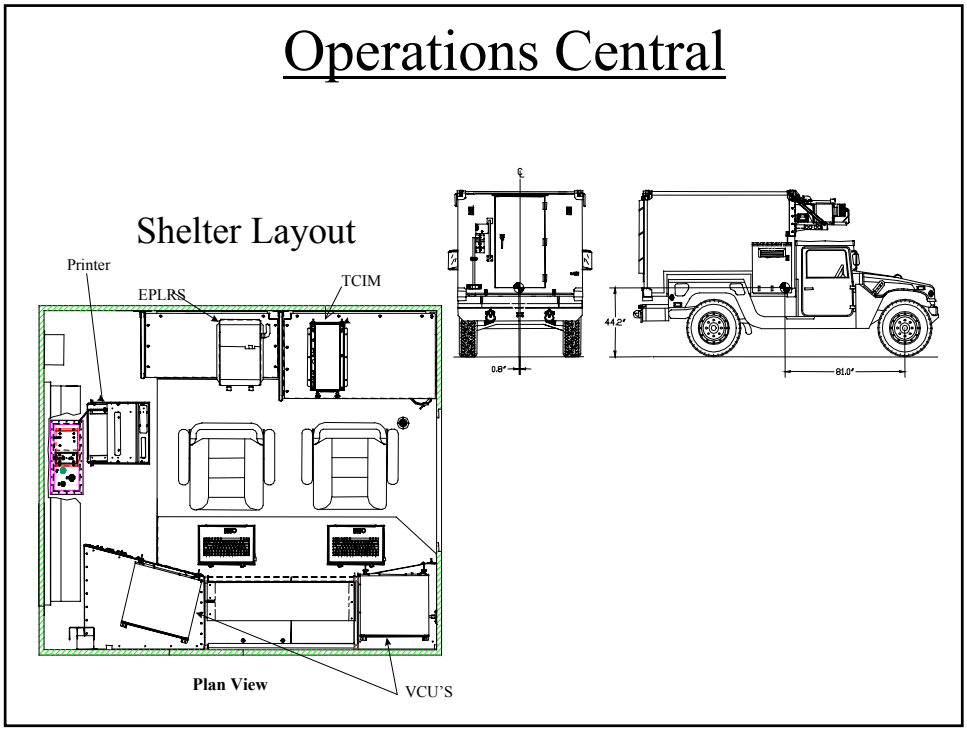

Figure E-8. Operations Central

PORTABLE OPERATIONS SUITE

The portable operations suite (POS) provides the capability to operate the radar system, with or without the OC, from a distance of up to 100 meters from the ATG. POS operations require that one VCU from the OC be removed and installed in the POS. The two ASIP radios contained in the ATG can be operated from controls on the POS. The POS can be moved and emplaced by two crewmembers.

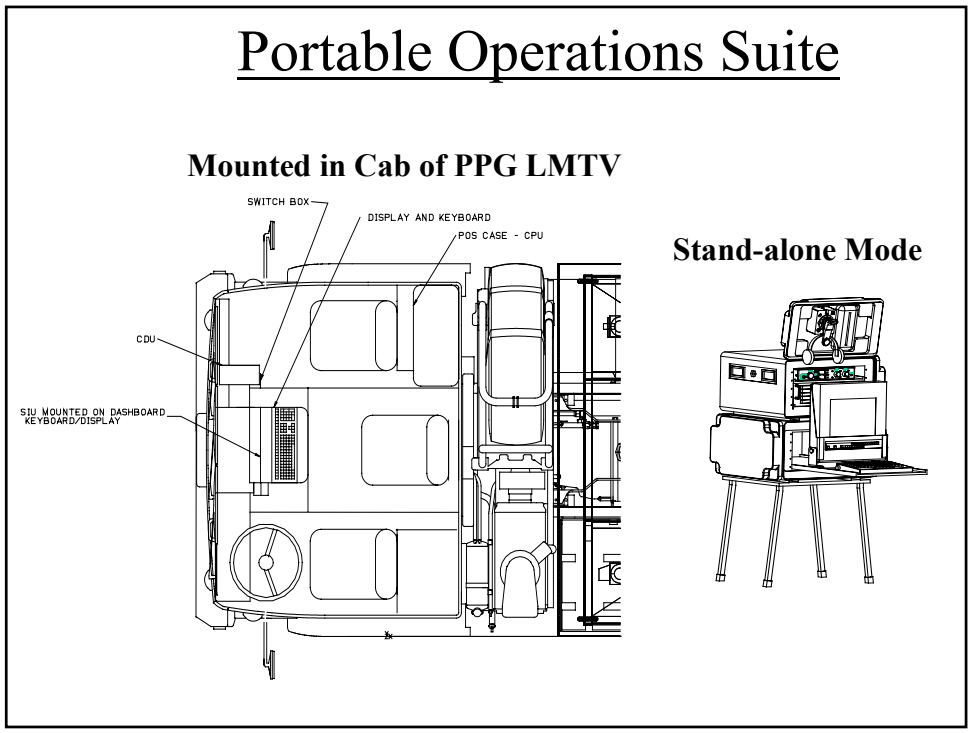

Figure E-9. The Portable Operations Suite

PRIME POWER GROUP

The PPG consists of a MEP-816A 60KW, 400 Hz generator set mounted on a Stewart and Stevens M1080 LMTV and a trailer mounted MEP 806, 60KW, 400 Hz generator set. The ATG power cables, POS cables and generator grounding equipment are mounted and stored on the LMTV. The LMTV contains a CHS-2 monitor and keyboard inside the cab to communicate with the central processing unit (CPU) and communications equipment in the ATG. This allows digital communications during movement.

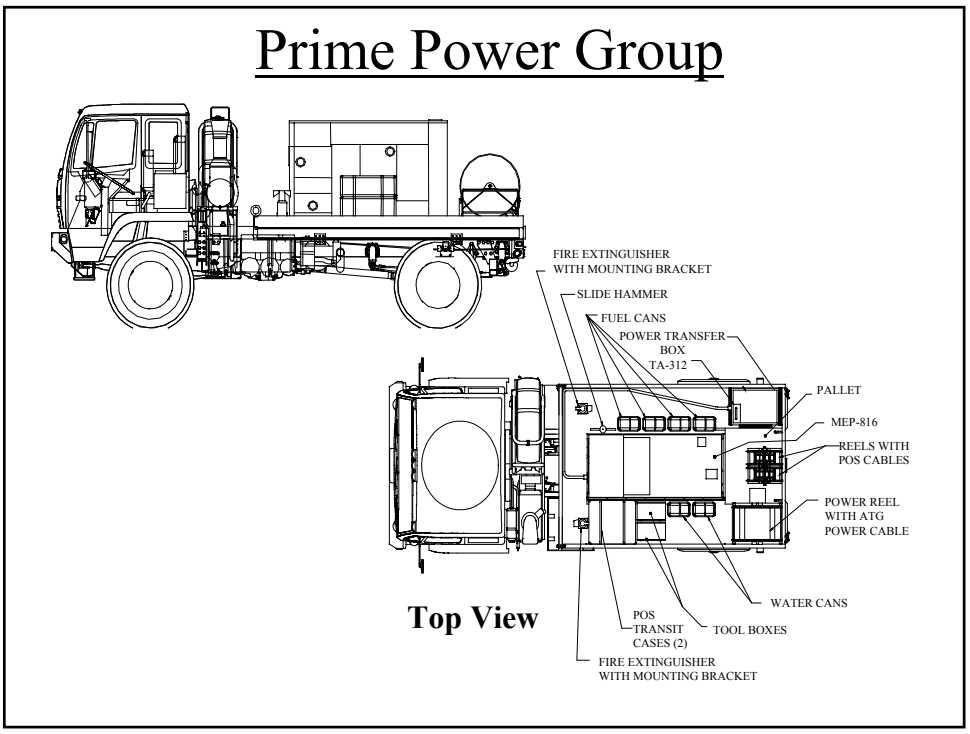

Figure E-10. The Prime Power Group

SYSTEM CAPABILITIES

MODES OF OPERATION

The Q-47 has three modes of operation. The normal mode, like the Q-37, allows the radar to detect hostile mortars, artillery and rockets. The fast scan mode increases the number of targets that can be tracked and the TBM mode allows detection of missiles and heavy rockets.

Normal Mode

Normal mode corresponds most closely to a combination of the hostile and friendly mode of the Q-37. However, the Q-47 can simultaneously perform hostile and friendly operations in the normal mode. In normal mode the Q-47 can acquire and track more than 25 simultaneous in-flight projectiles in the radar's coverage area. The radar provides target location, impact prediction and target classification. The target location error (TLE) for impact prediction is 300m. The TLE for hostile target location is discussed in paragraph later in this appendix.

Friendly operations allow the radar to register artillery at ranges of 3-60km. The radar can locate the point of airburst with a spherical error probable of 20m or .2% of range which ever is larger. The circular error probable (CEP) for a datum plane is located to the same accuracy. The in-flight projectile track capacity of the radar drops to 17 when conducting friendly fire operations.

Fast Scan Mode

Fast scan mode is very similar to normal mode. Fast scan mode allows the radar to acquire and track more than 50 simultaneous in-flight projectiles. Some degradation of range and accuracy occurs in fast scan mode with range and accuracy approaching the capabilities of the Q-37 radar.

TBM Mode

TBM mode supports theater missile defense (TMD) alerting by determining launch points, impact predict points and state vectors for TBM acquisitions. Two state vectors are determined, one at the missile's entry point and one at the missile's exit point from the radar beam. TBM data are transmitted to TMD activities with the 5.13 broadcast message using AFATDS.

Range and accuracy

The Q-47 provides a substantial increase in range and accuracy over the Q-37. Like the Q-37, the Q-47 is optimized for rockets and cannons. The probability of locating an enemy system in normal mode is .85 or higher throughout the entire range fan for a specific target category. The Q-47 can locate light and heavy mortars at ranges out to 18km and heavy mortars out to 30km with the same probability of location. It locates artillery and light rockets out to 60km and heavy rockets out to 100km. General planning ranges are 18km for mortars, 60km for artillery and light rockets and 100km for heavy rockets.

Figure E-11 shows the range fan for hostile operations in normal mode. The same range fan applies to the fast scan mode.

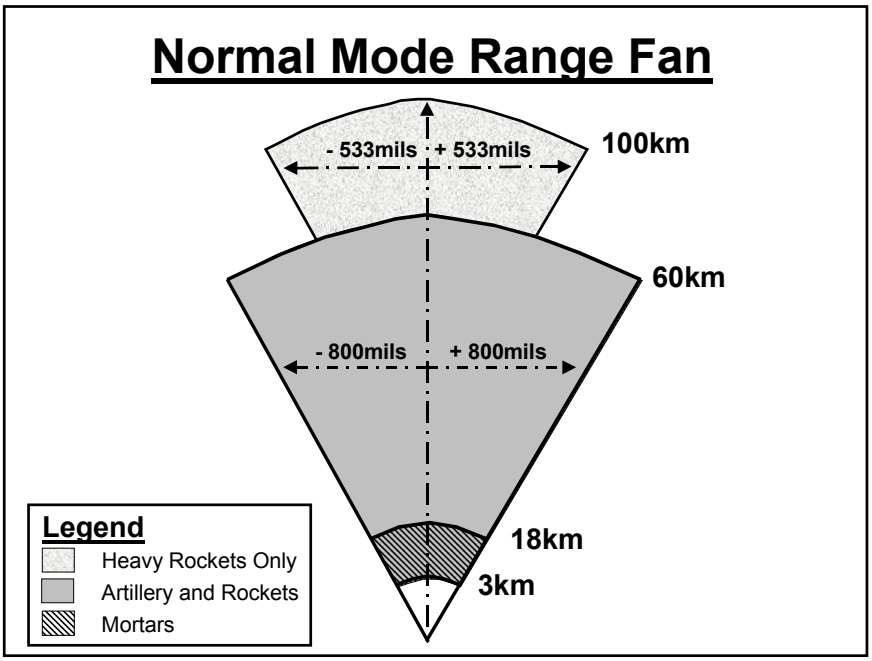

Figure E-11. Range Fan for Normal Mode Operations

In TBM mode, the Q-47 locates missiles and heavy rockets to the same accuracy as normal and fast scan modes. TBM mode provides an extend location range of 300km for missiles and 140km for heavy rockets. The radar fan extends from the radar, plus or minus 533 mils from the azimuth of orientation, to a range of 300km. The radar can also detect missiles in the area from plus or minus 533-800 mils from the azimuth of orientation. However, the range is significantly diminished. Figure E-12 depicts TBM coverage for missiles.

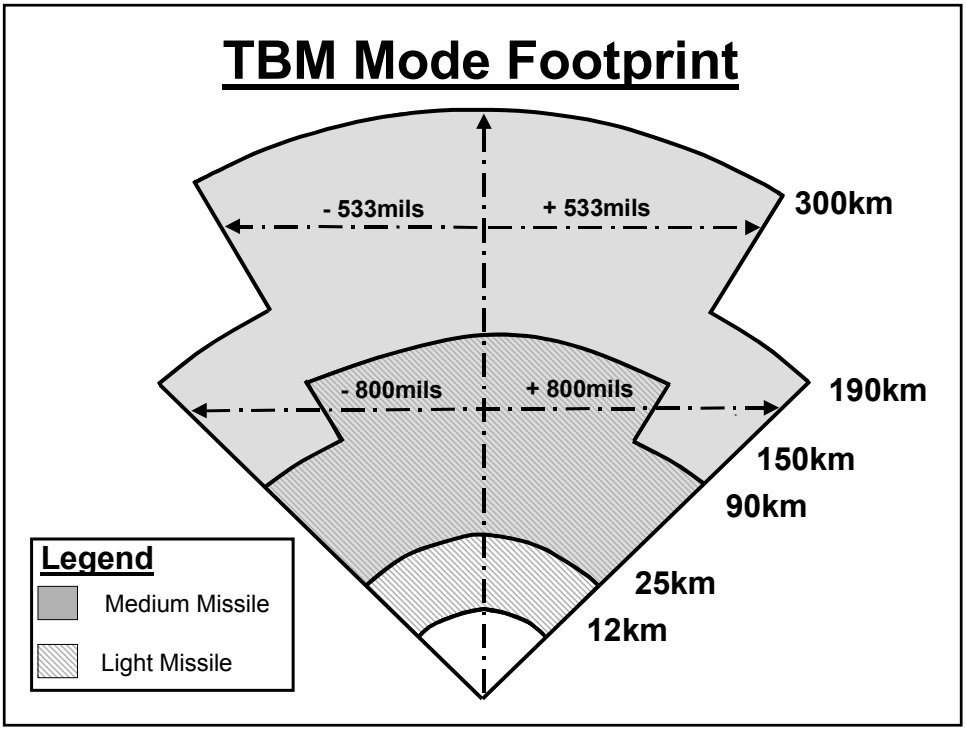

Figure E-12. TBM Coverage

TARGET LOCATION ERROR

Target location error (TLE) based on a .85 probability of location varies with range. TLE is an important consideration for determining the delivery system for attacking certain targets. The TLE is .25% range with an minimum TLE established by target type. Table E-2 provides TLE in meters by range band and target type.

Table E-2. Target Location Error

Target Category	Target Type	Ranges								
		10km	18km	30km	40km	50km	60km	100km	150km	300km
Mortar	Light	30m	45m							
	Medium	30m	45m							
	Heavy	30m	45m	75m						
Artillery	Light	30m	45m	75m	100m					
	Medium	30m	45m	75m	100m	125m				

Target Category	Target Type	Ranges								
		10km	18km	30km	40km	50km	60km	100km	150km	300km
	Heavy	30m	45m	75m	100m	125m	150m			
Rocket	Light	30m	45m	75m	100m	125m	150m			
	Heavy		50m	75m	100m	125m	150m	250m		
Missile	Light		50m	75m	100m	125m	150m	250m	375m	
	Medium			100m	100m	125m	150m	250m	375m	750m

The Q-47 has the ability to classify mortars, artillery, rockets and missiles. Table E-3 provides a break down of target types and U.S. surrogate systems.

Table E-3. Target Classifications

Target Category	Target Type	Caliber	U.S. Surrogate
Mortar	Light	60mm	60mm
	Medium	81-120mm	81mm &120mm
	Heavy	160-240mm	None
Artillery	Light	105-122mm	105mm
	Medium	130-155mm	155mm
	Heavy	170-240mm	None
Rocket	Light	70-179mm	None
	Heavy	180-300mm	MLRS
Missile	Light	340-530mm	ATACMS
	Medium	540mm-1100mm	None

Missiles are further characterized by a combination of length, launch weight, boost phase burn-time, and range. Light missiles are generally ≤ 7 meters in length, have a launch weight of ≤ 4500kg, have a boost phase burn-time of ≤ 45 seconds, and have a range of ≤ 300km. Medium missiles are generally ≤ 12 meters in length, have a launch weight of ≤ 7500kg, have a boost phase burn-time of ≤ 160 seconds, and have a range of ≤ 600km. Table E-4 shows typical threat weapon systems by target type.

Table E-4. Threat Weapon Systems

Target Category	Target Type	Threat Systems
Mortar	Light	
	Medium	Type 63, 2S9, 2S12, 2S23, 2B9, M1992
	Heavy	M-160, M-240, 2S4
Artillery	Light	D-30, D-74, 2S1, M 1974, M1977
	Medium	M-46, D-20, 2S3, 2S5, 2A36, 2S19, 2A65, M1973, M1975 (130mm gun), G5, G6, GCT, MkF3
	Heavy	M1989 KOKSAN GUN, 2S7
Rocket	Light	BM-11, BM-21, PRIMA
	Heavy	BM22, M1991 (240mm MRL), ASTROS II, 9A52
Missile	Light	FROG-7, SS-21, SS-23, SCUD-A, SCUD-B
	Medium	SCUD-C

SITE SELECTION

The technical aspects and characteristics of the Q-47 determine the requirements for site selection. These requirements include:

- Slope.
- Area in front of the radar.
- Screening Crest.
- Aspect angle.
- Electronic line of sight.
- Track volume.
- Proximity of other radars.
- Cable lengths.

The site selection requirements for the Q-47 are basically the same as those for the Q-37. The requirements that differ include the area in front of the radar and cable lengths.

AREA IN FRONT OF THE RADAR

The area in front of the antenna should be clear of foliage that extends above the bottom of the antenna. This clear area minimizes attenuation of the radar beam. This area should extend 300 meters in front of the radar. The ideal site will have a clear area in front of the radar that has a gentle downward slope for approximately 300 meters and then gradually rises up to the screening crest. This reduces multipath errors. Multipath errors are errors in target location created when radar transmit or return signals travel by more than one path. Finally, the area in front of the radar should be clear of personnel for a distance of 217 meters. Safety considerations are discussed later in this appendix.

CABLE LENGTHS

Cable lengths must be considered when selecting a site for the Q-47 radar. The cables determine the extent to which the components of the radar can be dispersed. The required dispersal of system components is determined by the terrain contour, foliage, site access, and threat. Ideally, the radar components should be positioned to take advantage of naturally available cover and concealment. The cable lengths dictate the maximum dispersal. Table E-5 shows the cable lengths for the Q-47.

Table E-5. Cable Lengths

Cable	Length (ft.)
Signal/Control/LAN Cable (x2)	165 (50m)
ATG Power Cable	100 (30m)
OC Power Cable	100 (30m)

Based on these lengths, the OC or POS could be placed up to 90 meters from the ATG and 20 meters from the prime power group. 10 meters of slack should be maintained in the cables to prevent damage to the connectors and

cable ends. To obtain the maximum dispersal between the OC and the PPG both sections of cable must be used at the same time. Figure E-13 shows the emplaced radar and actual cable lengths.

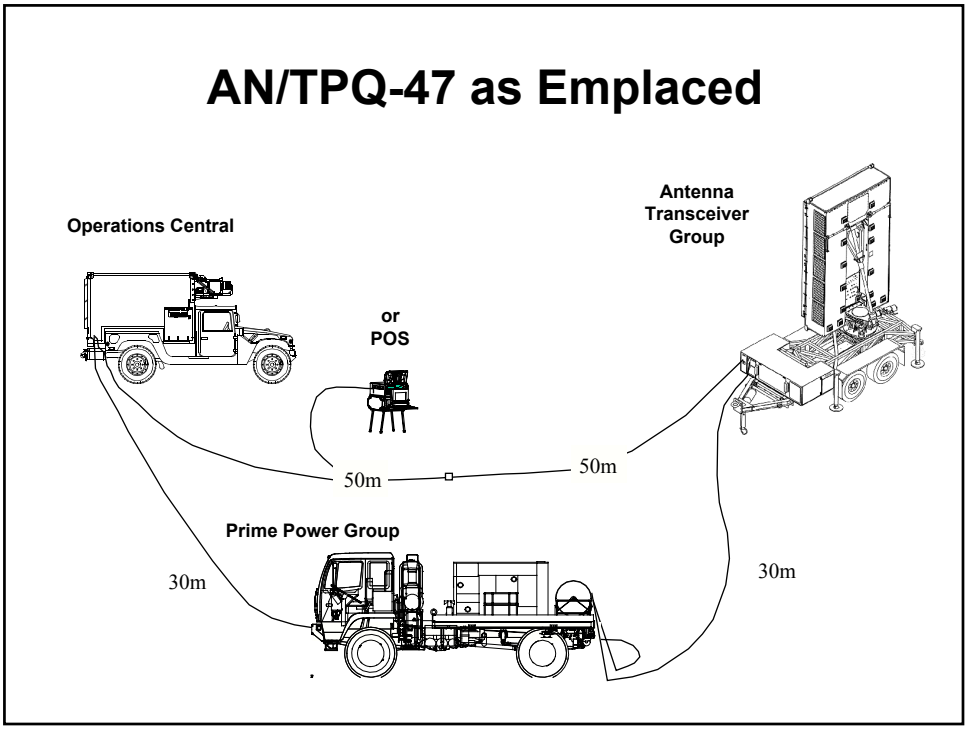

Figure E-13. Emplaced Q-47

POSITIONING

Positioning is based on the technical requirements and capabilities of the radar and tactical considerations. The overriding factor in positioning is mission accomplishment. Paramount in selecting radar positions is mission, enemy, terrain, troops, time available, and civil considerations (METT-TC). The S2/targeting officer or counterfire officer from the controlling FA headquarters designates the general position area. The radar section leader selects the actual radar sight within the position area.

TACTICAL CONSIDERATIONS

The position area for the Q-47 is selected based on the IPB, the range capabilities of the radar, and METT-TC. A through analysis of METT-TC will dictate which factors are most important. Generally, in a traditional battlespace, the Q-47 is positioned far enough from the FLOT to acquire the enemy weapons based on IPB, prevent loss of the radar to enemy action, and avoid unnecessary movement. This maximizes radar coverage and cueing time. Given the 3km minimum range and the necessity to avoid conflicts with maneuvering friendly forces, the Q-47 is normally positioned 8-12km from the FLOT. This rule of thumb may change based on the tactical situation. In early entry operations and TMD operations, the Q-47 may be positioned

further to the rear or in an intermediate staging base (ISB). In general, planning ranges for the Q-47 are 18km for mortars, 60km for artillery and 100km for rockets. Planning ranges may be modified based on the mode of operation and the target sets to be acquired. Of the tactical considerations, only the considerations for mission differ from the METT-TC considerations for other Firefinder radars.

Mission

The Q-47 must be emplaced where it can best accomplish its mission. Several factors drive positioning in relation to mission considerations. The supported unit, commander's guidance, associated command relationship, and required sector of search dictate in general where the radar must be positioned. The requirements to conduct hostile and friendly operations or operate in TBM mode add specificity to positioning requirements. Further, the requirements to establish priority zones influence where a radar must be positioned.

SURVIVABILITY CONSIDERATIONS

Survivability of the radar must be considered when selecting radar positions. Radars are susceptible to enemy ground attack, air attack, indirect fires and electronic warfare. The Q-47 also produces a significant heat signature that can be detected by infrared detection devices. A through IPB will identify threats to the Q-47.

SAFETY

Safety is an important consideration when operating and working around the Q-47. Like the Q-37, one must be aware of wind and radiation hazards. However, the Q-47's unique design presents additional considerations.

RADIATION

When the radar transceiver is energized, it poses a microwave radiation hazard to personnel. The hazard distance for the Q-47 is much greater than the distance for the Q-37. The hazard distance for troops extends in front of the radar for 217 meters over the radars full 1600-mil area of scan. The radar also poses a hazard for electrically detonated explosives. Figure E-14 depicts the radar's radiation hazard area.

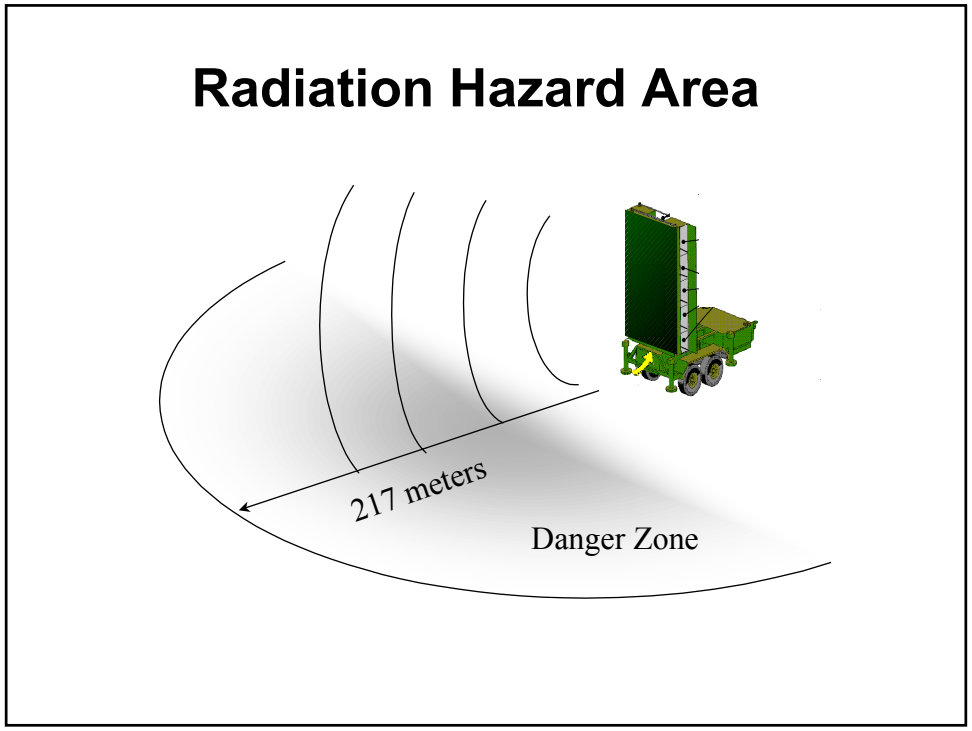

Figure E-14. Troop Radiation Hazard Area

HOT SURFACES

The Q-47 antenna is air-cooled antenna unlike the Q-37 that has a liquid-cooled antenna. Therefore, the antenna and control surfaces generally maintain a higher temperature. Some components may require a cool down period before performing maintenance. Control panel surface temperatures should normally be less than 120 degrees Fahrenheit at an ambient temperature of 77 degrees during normal operation. Other surfaces should not exceed 140 degrees Fahrenheit at an ambient temperature of 77 degrees. Surface temperatures may exceed these temperatures when ambient temperatures are higher.

WIND

Because of the large surface area of the antenna**,** high wind velocity can cause serious safety hazards. When the wind velocity reaches a constant speed of 40 mph or higher or wind gusts exceed 75 mph the antenna must be placed in the stowed position.

LIFTING HAZARDS

Many of the Q-47's line replaceable units (LRU) weigh in excess of the 37-pound single person lift requirement. Exercise care when removing or transporting these items. Table E-7 provides a list of LRUs exceeding the one-person lift requirement.

Table E-7. LRU Weights

LRU	Weight (lbs)
MAPS	44
Receiver	51
Exciter	56
BSC	60
ARC	63
PAM	66
PSU (1)	67
APU	73
DPU	100

ANTENNA ROLL OVER

The ATG is top heavy and can present a roll over hazard during positioning. Care should be exercised when emplacing the antenna because the antenna can unexpectedly move after leveling under certain conditions. The ATG should be sited on level ground. The ATG center of gravity (CG) may shift if sited on sloped or soft terrain. High winds may exacerbate this condition. Combinations of high wind load and CG movement may contribute to tip over. The Q-47 is equipped with software to monitor and alert the operator if the roll angle exceeds 2 degrees.

NOISE

Hearing protection should be worn when working around power generation equipment and the ATG. Noise generated by the ATG cooling fans may generate noise levels in excess of 85 decibels in areas adjacent to the ATG during operations.

SECTION II – OPERATIONAL ASPECTS

THEATER MISSILE DEFENSE OPERATIONS

The Q-47 radar provides the capability to conduct theater missile defense (TMD) operations. Depending on the theater and the theater's level of maturity, the Q-47 might be required to support a joint force headquarters, Army forces commander (ARFOR) or corps as they conduct TMD operations.

The radar may or may not be deployed as part of its parent organization. These factors will directly influence the command and support relationship established for the radar and its ultimate employment. In cases where the radar deploys or operates without its parent organization, support requirements become a major consideration. This appendix discusses TMD, doctrine, Q-47 TBM mode capabilities, and TTP for Q-47 participation in TMD operations.

TMD MISSION

Theater air and missile defense operations encompass all activities focused on the identification, integration, and employment of forces supported by theater and national capabilities to detect, identify, classify, locate, track, discriminate, minimize the effects of and destroy air and theater missile threats (to include large-caliber rockets). TMD protects the force and critical assets from attack by theater missiles, which include ballistic missiles, cruise missiles, air-to-surface missiles, and large caliber rockets. Doctrinally, tactical ballistic missiles (TBM) are surface launched missiles with ballistic trajectories. These missiles are further characterized as short-range ballistic missiles (SRBM) and medium-range ballistic missiles (MRBM). SRBM include TBMs with ranges up to 1000km. MRBM have ranges from 1000 to 3000km. The light and medium missile classifications of the Q-47 both fall into the SRBM category. SRBM include the entire family of SCUD missiles.

Attack Operations

Attack operations destroy, disrupt, or neutralize theater missile (TM) launch platforms and supporting command, control, and communications (C3) nodes, logistic structures, and reconnaissance, surveillance, and target acquisition (RSTA) platforms. Attack operations include offensive action by air, land, sea, and special operations forces. The joint force commander (JFC) normally tasks component commanders to conduct attack operations within their area of operations (AO). Subordinate commanders control attack resources and coordinate and their operations according to joint doctrine and procedures. The joint force air component commander (JFACC) is normally the supported commander to plan and conduct attack operations against TM that are outside other component commanders AO.

Attack operations can be preemptive or reactive. A sustained effort is required to reduce the enemy's TM capability and involves the execution of mutually supporting tasks. The detection, acquisition, classification, identification, tracking, and attack tasks are highly dependent on a near real time C4I process and rapid targeting capability. Attack operations use all-source intelligence, missile-warning systems, air defense radar, and Q-47 radar to locate and target enemy TM systems, their components, and supporting nodes.

Operational Objectives

The JFC employs theater missile defense forces to achieve two primary operational objectives: gain control of the air environment and protect the force and selected assets. At the operational level, the Army contributes to

theater counterair operations and to theater missile defense. Army combined arms forces provide support for offensive counterair (OCA), defensive counterair (DCA), and TMD active defense and attack operations.

Tactical Objectives

Objectives of air and missile defense operations at the tactical level are to protect corps and division forces as they plan and execute battles and engagements. Every participant in Army air and missile defense operations, maneuver, fire support, aviation, and intelligence, has a role in achieving those objectives, as do the joint forces that support corps and division operations. Air and missile defense objectives at the tactical level are an extension of the operational-level objectives, but are more specific. Tactical-level air and missile defense operations support the overall objectives of corps and divisions. The emphasis at the tactical level is on protecting the force rather than on gaining control of the air environment or protecting geopolitical assets.

THE ARMY AND AIR DEFENSE MISSILE COMMAND (AAMDC)

The AAMDC is the Army's operational lead for Army theater air and missile defense. In wartime, the AAMDC supports the ARFOR commander or, if designated, the joint force land component commander (JFLCC). The AAMDC is normally under command of the ARFOR commander, or if a JFLCC is designated, the AAMDC may be OPCON or TACON to the JFLCC. The AAMDC usually collocates with the ARFOR/JFLCC headquarters, but dependent on METT-TC, may collocate with the joint air operations center (JAOC). The location of the commander and his role is also dependent on METT-TC. Normally, the AAMDC does not have C^2 of any attack operations (field artillery or aviation) or passive defense forces (chemical). However, the AAMDC operations section monitors aspects of their operations/capabilities that may impact AAMDC operations. In the event of a missile launch, the operations section receives missile launch, state vectors, and TBM impact points from the Q-47 and other air defense systems, disseminates early warning, and after analysis passes targeting recommendations on the enemy's launch platforms and associated infrastructure to the deep operations coordination cell (DOCC). It also develops plans to support future operations and assists integration of TMD time sensitive and planned air tasking order (ATO) target missions.

AAMDC Attack Operations Cell

The attack operations cell supports ARFOR deep operations and joint force offensive counterair (OCA) attack operations through analysis and targeting focused specifically against the TM threat. Analysis includes such actions as developing TM intelligence requirements (IRs), building operational patterns and profiles, identifying trigger events, analyzing launch events, conducting countermobility analysis, and identifying information operations (IO) warfare vulnerabilities. Q-47 acquisition data provides input to support these analyses. Targeting actions include nominating attack strategies and submitting target nominations and mission requests. These validated TM

nominations are normally forwarded electronically to the DOCC via AFATDS for immediate or preplanned execution.

Attack Operations Cell Organization

The attack operations cell and its automated equipment are shown in Figure E-15. This equipment includes the automated deep operations coordination system (ADOCS), the advanced field artillery tactical data system (AFATDS), the all source analysis system remote workstation (ASAS RWS), the generic area limitation environment (GALE), the joint services workstation (JSWS), and laptop computers.

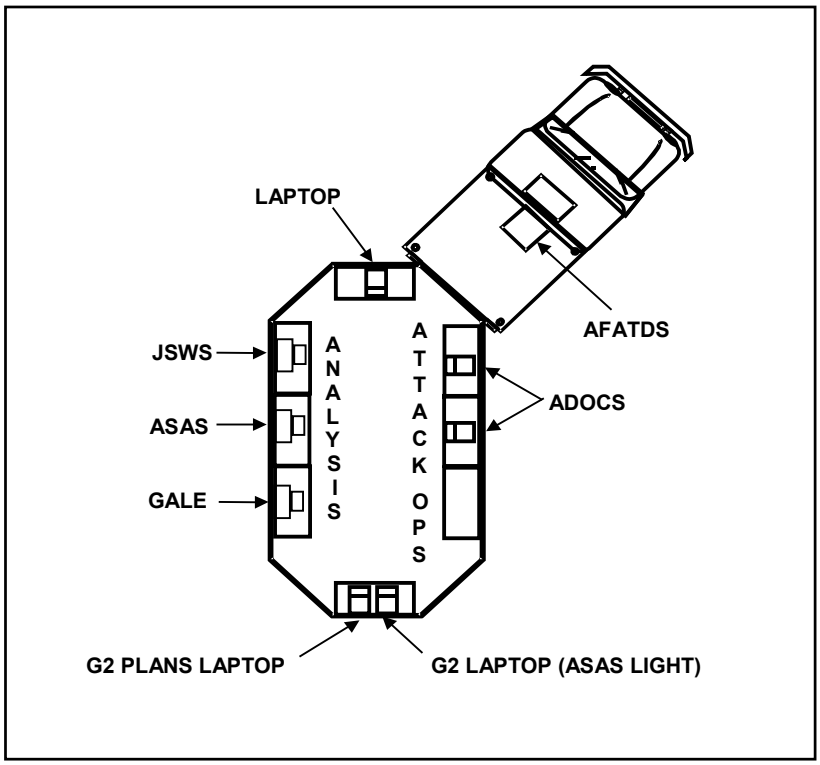

Figure E-15. Layout of Attack Operations Cell

This equipment is described below:

- ADOCS is an integrated set of automated tools used for mission planning, coordination, analysis, and data management. It displays a variety of data including friendly and enemy unit locations, air corridors, restricted fire areas, and operational graphics. It is used to submit TM target nominations to the DOCC and provide friendly artillery and fire support coordination measure (FSCM) situational awareness to the attack operations cell and LNOs.
- AFATDS is an automated workstation that displays friendly artillery database information and facilitates management of fire support operations by processing fire mission requests and air support mission requests. It is used to submit TM target nominations to the DOCC and provide friendly artillery and FSCM situational awareness to the attack operations cell and LNOs. The Q-47 transmits target location, impact predict location and state vectors from target acquisitions directly to this AFATDS.
- ASAS RWS receives and correlates data from strategic and tactical intelligence sensors and sources. This data includes electronic, signal, imagery, and human intelligence. The RWS displays the enemy and friendly situations and includes tools that can be used to perform IPB, situation and event analysis, and target planning.
- GALE is an automated workstation that contains a comprehensive terrain database. It is capable of analyzing terrain and predicting the

most probable locations of enemy launch areas, forward operating bases, hide sites, and support areas. It is also capable of modeling the movement of enemy mobile launch platforms and predicting where they are going, what roads they will be using and the time required to reach their destinations.

- The JSWS is an automated workstation that receives surveillance imagery from the joint surveillance and target attack radar system (JSTARS) platforms that are imaging fixed targets or tracking enemy mobile launch platforms. The JSWS displays this imagery, enabling the operator to provide accurate targeting information, including fixed and mobile target locations, speed, target classification, and direction of movement.
- The laptop computers are used for operational, administrative, and intelligence information dissemination purposes and providing connectivity via the SIPRNET to AAMDC staff and LNOs and other SIPRNET users.

Liaison

The AAMDC provides liaison teams to support its TMD mission. It deploys liaison teams to all major theater C2 headquarters and to the ARFOR DOCC, BCD and ACE. At the DOCC (and when necessary at the analysis and control element (ACE) based on METT-TC), the AAMDC liaison teams assist with the air and missile IPB and bring an air and missile focus to deep operations. The AAMDC nominates TAMD targets for prosecution either within the air tasking order (ATO) cycle or as a time sensitive target. The AAMDC DOCC LNOs assist in the target nomination process, provide the AAMDC with non-TMD deep targets of interest, inform the AAMDC of the availability of Army attack assets, and monitor the status of the target nomination request. These liaison teams have the ability to digitally receive and process Q-47 acquisitions. This is an important capability that provides flexibility when employing Q-47 radars in support of TBM operations.

ARFOR TMD OPERATIONS

The AAMDC is responsible for conducting TMD operations for the ARFOR when the ARFOR is responsible for TMD operations in its AO. The radar support for the ARFOR is provided by Q-47's from an IBCT, IDIVARTY, divisional TAB or CTAD depending on the size of the force acting as the ARFOR and the maturity of the theater. A division or corps headquarters is likely to act as an ARFOR. The digital architecture and command and support relationships for the Q-47 radars are basically the same whether the corps or division acts as the ARFOR. Only the parent organization of the radars would differ.

Corps as ARFOR Headquarters

When the corps acts as an ARFOR headquarters, Q-47 support should normally be provided by the CTAD allocated to the corps. The number of radars placed in the TMD mode is determined by the IPB and commander's guidance. The AAMDC conducts targeting for TMD operations. However, the Q-47s remain under the command of the corps/ARFOR. The radars have an

assigned command relationship. The Corps FSE/DOCC controls the radars. Acquisitions are reported to the corps FSE/DOCC, AAMDC and AAMDC DOCC LNO. Figure E-16 depicts the digital architecture for a corps acting as an ARFOR with a supporting AAMDC.

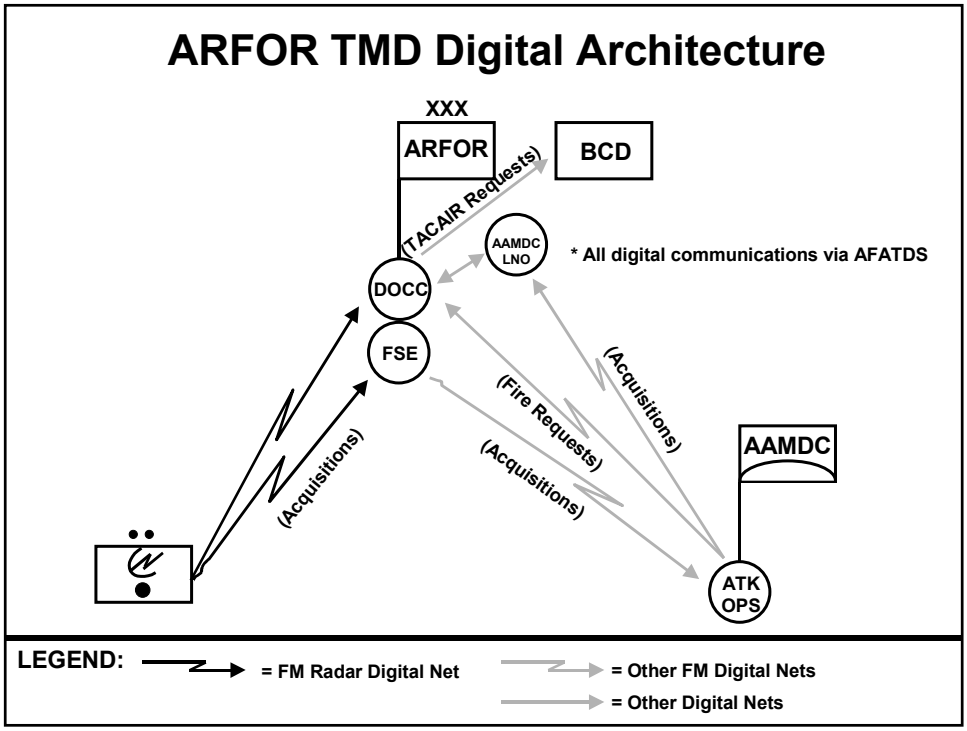

Figure E-16. ARFOR TMD Q-47 Digital Architecture

TBM acquisitions are transmitted from the radar to the DOCC/FSE, AAMDC and AAMDC LNO on one digital net via AFATDS. The information received in the DOCC is used for targeting, situational development and attack operations. The information received at the AAMDC is used for TMD targeting, passive missile defense and cross-cueing air defense systems such as the Patriot radar. Care must be taken to avoid duplication of effort. One method for preventing duplication is to specify which agency will generate target nominations or fire requests for specific targets. The DOCC/FSE should process and conduct attack operations for heavy rockets. The corps has assets to immediately attack these targets based on range and the TLE of acquisitions. The AAMDC should process missile acquisitions since the TLE of the acquisition is too large for ATACMS and the target dwell time is too short. The AAMDC can use the acquisitions in conjunction with other intelligence systems to develop a viable target for ATACMS or generate an air nomination. All target nominations and air requests are sent from the AAMDC to the DOCC for processing.

Missile targets could be attacked immediate upon detection with TACAIR. The TLE and response time requirements are such that the target can be attacked even if it departs the launch point. The options for air attack are to pass the target through the BCD to an aircraft flying a TMD AIRCAP, if

available, or to divert an AI mission. Air requests could also be sent directly from the AAMDC to the BCD through the AAMDC LNO at the BCD. This procedure should be coordinated in advance to avoid duplication of effort.

CORPS AND DIVISION TMD OPERATIONS

Corps commanders exercise control over most of the ground forces in the theater. Objectives of air and missile defense at the corps level are protecting the force, providing freedom to maneuver, controlling the air environment, and destroying enemy air and missile power on the ground and in flight. At division, the focus shifts increasingly toward providing freedom to maneuver by protecting the force. These perspectives relate directly to the different battlefield characteristics and requirements at each command level. Q-47 radars are managed to accomplish these objectives.

Corps Employment of Q-47 Radars

Corps has a CTAD to accomplish its counterfire and missile defense objectives. Depending on the TBM threat, corps may place one or both Q-47s in TBM mode. In the absence of a creditable TBM threat, both Q-47s would operate in normal or fast scan mode. Acquisitions from the Q-47s would go directly to the corps FSE/DOCC and, if so designated directly to a field artillery brigade or subordinate battalion for attack. Acquisitions would also go to the corps G2 to support intelligence operations. Figure E-17 depicts a digital architecture for corps TBM operations.

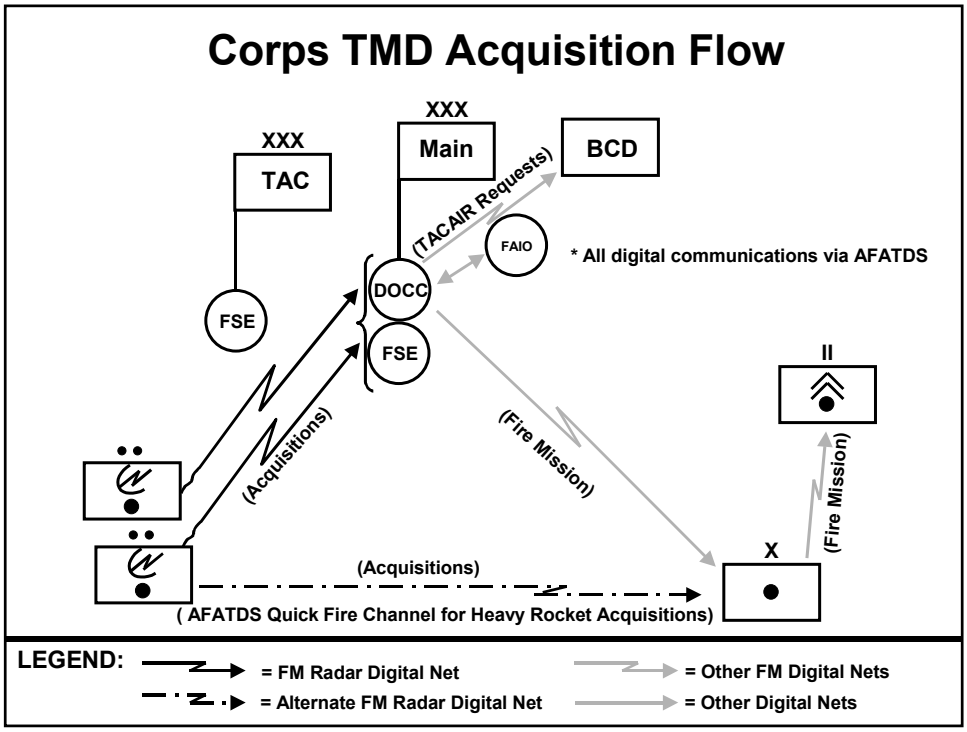

Figure E-17. Corps TBM Acquisition Architecture

Division Employment of Q-47 Radars

A division uses the two Q-47 radars from the radar platoon of its target acquisition battery to provide TBM support. In a unit organized with an IDIVARTY, three Q-47 radars are available in the TA platoon of the HIMARS battalion. Further, each IBCT has a Q-47 radar upon which the division could task. Normally, the division would be focused on counterfire and the Q-47s would operate in normal or fast scan mode. The division might place one Q-47 in TBM mode to obtain the addition range capabilities for detecting heavy rockets. Further, an AFATDS quick fire channel might be established between a Q-47 and the counterfire headquarters or a subordinate battalion to facilitate immediate engagement of targets. A division organized with an IDIVARTY has additional flexibility. A division in an early entry scenario may routinely place a radar in TBM mode when acting as an ARFOR headquarters. Q-47's in heavy or Army XXI divisions would send acquisitions to the designated counterfire headquarters and/or FSE. The FSE processing the acquisitions in the heavy division is the main FSE. The TAC FSE would receive the acquisitions in the ARMY XXI division. In divisions organized under the interim or object force structure, acquisitions would be transmitted to the fires and effects coordination cell (FECC).

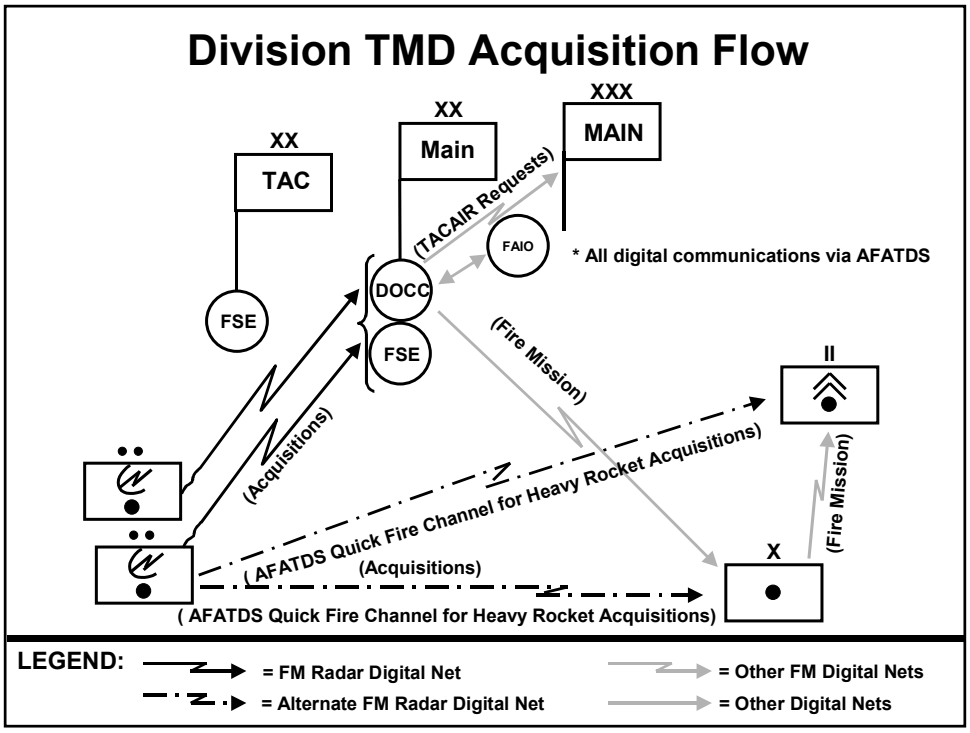

Figure E-18. Division TBM Acquisition Architecture

Q-47 TBM CAPABILITIES

In TBM mode, the Q-47 can detect TBMs at ranges from 12-300KM. The associated target location error (TLE) is 50m or .25% of range for light missiles and 100m or .25% for medium missiles whichever is greater. The maximum TLE is 750m at 300km for medium missiles. The TLE is too large to provide targetable data for ATACMS Block I/IA at most ranges without validation by a second detection source. The main detection footprint extends from the radar +/-533mils from the azimuth of orientation out to a range of 300km. The radar can also detect missiles in the area from plus or minus 533-800 mils from the azimuth of orientation. However, the range is significantly diminished. The minimum range is 12km for light missiles and 25km for medium missiles (See Figure E-12). The Q-47 can also detect heavy rockets in TBM mode. For missile targets, the Q-47 will compute and transmit a missile's state vector, launch point, and impact predict point in near real-time.

Target Categories

The Q-47 categorizes detections in TBM mode as light or medium missile or heavy rocket based on size, velocity and trajectory. Heavy missiles are not detected as their range is greater than that of the Q-47.

Light Missiles. Light missiles are guided during part of their trajectory and have a free flight stage. They are the fastest missiles during the initial burn stage and are easier to detect during the boost stage of their ascent. Typically

the range of these missiles is proportional to the weight of their warhead. Warheads filled with gaseous agents or ultra-light explosive devices would extend the range considerably. Ranges usually vary from 25km to 150km. The Q-47 classifies detections as light missiles based on size, velocity and trajectory. Velocities vary from 800 to 1500 meters per second. ATACMS is considered a light missile. Threat systems in this category include the SS-21, SS-23, SCUD-A, and SCUD-B.

Medium Missiles. Medium missiles fly from 40-300km at velocities of 1100 to 2300 meters per second. They are missiles similar in performance to the SCUD and SS-21. There is no U.S. weapon in this category. The threat system in this category is the SCUD-C. The NoDong is a heavy missile based on range.

Heavy Rockets. Heavy rockets are larger than 155mm, may be programmed internally, and may have a guidance-affected trajectory. They normally fly through more than one layer of atmosphere during their trajectory and may carry multiple payloads. These rockets have a velocity from 700 to 1200 meters per second. The Q-47 can detect heavy rockets at ranges up to 100km. MLRS is classified as a heavy rocket. Threat systems in this category include the BM22, M1991 (240mm MRL), ASTROS II and 9A52.

CORPS COUNTERFIRE

The increased range capability of the Q-47 and the allocation of two Q-47 radars to each corps provide the corps with a capability to conduct reactive counterfire without stripping a division of its assets. The level of reactive counterfire operations must be balanced with the requirements to conduct TMD operations. The introduction of reactive counterfire operations at the corps is a departure from current counterfire roles. The corps role in current doctrine is normally focused on deep, proactive, counterfire. In most situations, the division orchestrates and executes counterfire in support of corps close operations. The corps provides resources to the division. This allows an orderly and calculated division of labor. Just as the division separates and deconflicts the radar coverage and counterfire efforts of the division and maneuver brigades, so must the corps deconflict the efforts of the corps and division. The division uses the common sensor boundary (CSB) to segregate the coverage areas for the Q-36 and Q-37. The corps must also segregate the coverage areas for division and corps Q-47 to prevent duplication. One method is for the corps to establish a corps common sensor boundary (CCSB). This measure is established based upon IPB and analysis of the enemy fire support system. The corps normally places the CCSB to segregate the responsibility for locating and attacking DAGs and AAG/AGRAs. The corps could also establish a phase line to delineate areas of coverage. In either case, the location of fire support coordinating measures relative to the CCSB or phase line must be considered. CCSB should be placed on or forward of the CFL or FSCL, when possible, to eliminate the need to clear targets prior to engagement.

DIVISION COUNTERFIRE

Counterfire operations at the division are enhanced by the Q-47. However, the basic procedures unchanged. Reactive counterfire is affected by the Q-47's increased range and ability to classify targets. The ability to classify targets enhances counterfire operations by identifying specific target types for generation of fire missions based on the unit's High Payoff Target List (HPTL). This target classification capability can also be leveraged by the TPS when combined with the target build-up function in AFATDS. The TPS can establish a target build-up area with an associated target type that will generate a fire mission when the designated number of targets is located in the specified area. Finally, the enhanced range provides the capability to acquire the majority of threat artillery and rocket systems. This enhanced range also provides the corps with a system capable of detecting threat systems in areas where the corps normally conducts its operations.